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(54) **Adhesive coatings for abrasive products**

(57) An abrasive element comprising a substrate bearing layer of a moisture-cured hot melt polyurethane adhesive (= make) having abrasive particles embedded therein. Hot melt adhesives are compatible with many water-based size (= second binder layer) formulations, the moisture content of the size participating in the curing of the make adhesive. The size layer may comprise acrylic, polyurethane, phenol, melamine or urea formaldehyde adhesives or a water-based epoxy adhesive. The abrasive element may comprise a supersize layer or a presize layer composed of ethylene vinyl acetate, polyethylene or polyamide.

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ABRASIVE ELEMENTS

This invention relates to abrasive elements and to their preparation.

Abrasive products are normally prepared by coating one surface of a substrate with a first binder layer having adhesive properties, often referred to in the art as the "make". Particles of abrasive material are applied to the coated substrate and partially embedded therein. A layer of a second binder, often referred to as the "size", is then applied to the material. The thickness of the second binder layer regulates the amount of the abrasive material extending above the binder medium. Anti-loading materials have generally been included in a further optional layer, referred to in the art as the "supersize".

The adhesives used to form the make are generally water- or solvent-based and include phenolic resins, urea-formaldehyde, melamine-formaldehyde and combinations thereof. Other adhesives which have been used are based on animal hide glue and starch. Similar adhesives have been used for the size.

Many of the known adhesive systems which have been used are of low solids content requiring a high energy input for drying and the careful selection of backing materials. In the case of solvent-based adhesives, apparatus to extract solvent emissions can also be needed. Such extraction apparatus may also extract the fines from the abrasive particles leading to processing problems.

It is an object of the invention to provide an alternative adhesive system for the make of an abrasive element.

Therefore according to the present invention there is provided an abrasive element comprising a substrate bearing layer of a moisture-cured hot melt polyurethane adhesive having abrasive particles embedded therein.

It has been found that the use of a moisture-cured hot melt polyurethane adhesive as the make in an abrasive element provides a number of advantages over traditional water- and solvent-based systems. The hot melt adhesive is used at 100% solids content and by suitable selection of the application temperature will maintain the desired orientation of the abrasive particles. The hot melt adhesive is compatible with many size formulations and allows the application of water-based size over the make and abrasive particles, the moisture content of the size participating in the curing of the make adhesive ensuring strong bonding between the make and the size. Other sizes may be employed, e.g. hot melt or solvent-based formulations, which sizes may be applied before or after curing the make adhesive.

Hot melt adhesives are 100% solid polymeric materials which form bonds on cooling. They are generally composed of a combination of resins, waxes and stabilizers. Coating is normally by die coating or extrusion, but can also be by spray coating. Moisture-cured polyurethane coatings are isocyanate-terminated prepolymers which, after application, are cured by reaction of the residual isocyanate groups with moisture. The amino groups initially formed react with more isocyanate groups to form urea linkages.

The moisture curing hot melt polyurethane (HMPU) may be applied to any substrate which will withstand the application temperature of the adhesive. Suitable substrates include paper, cloth and foam. The HMPU may be coated directly on the substrate or a priming or presize layer may be applied prior to its application. Such presize layers may be solvent-based, water-based or hot melt. The presize layer is conveniently hot melt since it may readily be applied at the same coating station as the HMPU make. Presize layers are particularly useful on substrates which have rough surfaces or surfaces with voids e.g. open-cell foams, and

woven and non-woven fabrics, since it assists in smoothing the surface and reduces the amount of HMPU required, which tends to be a more expensive component than the presize material. Presize layers are not normally required on closed-cell foams and other substrates having a substantially sealed surface.

Suitable HMPU adhesives are commercially available e.g. under the trade names Tivomelt 9617/11, 9628 and 9635/12 from Tivoli; Purmelt QR116 and QR3310-21 from Henkel and Jet Weld TS-230 from 3M.

Suitable size materials include those commercially available under the trade names Evode DP-90-4101, a water-based acrylic from Evode; Witcobond 732, 769 and 788, water-based polyurethanes from Baxenden, urea, melamine and phenol formaldehydes, water-based epoxy systems, and combinations thereof. It is also possible to use calcium stearate in a binder, normally an acrylic binder. The size layer may include additives such as grinding aids, lubricants, antiload compounds, etc.

Suitable presizes including those commercially available under trade names Thermaflow 6876, hot melt ethylene vinyl acetate from Evode, 3M 3748 a hot melt polyethylene from 3M and 3M 3789 a hot melt polyamide from 3M. It is also possible to use calcium stearate in a binder, normally an acrylic binder, as a presize. In some circumstances, a pre-formed film may be applied to the substrate. This is a useful option where the substrate is a foam, or a woven or non-woven fabric.

The abrasive elements may also comprise a supersize, preferably of the type disclosed in EP-0433031. Particularly preferred supersize compositions comprise calcium stearate and a fluorinated additive e.g. FC396 from 3M, in a water-based acrylic binder, e.g. Vinacryl 71322 from Vinamul.

The polyurethane used in a given application will be selected according to the particular requirements. As a general guide, polyurethanes having viscosities in the

range 3,000 to 12,000 mPa.s (Brookfield) at 120°C are suitable, but those exhibiting higher or lower values may be appropriate in certain circumstances. For example, a less viscous polyurethane will normally be required if a lower coating temperature is to be used, and a more viscous polyurethane may be suitable if a higher coating temperature can be tolerated.

The make coating is generally applied by heating the HMPU to a temperature at which the viscosity is suitable for coating and applying the molten material to the substrate by an extrusion die. Coating temperatures depend upon the particular HMPU but are generally in the range 50 to 200°C, usually in the range 120°C to 160°C. The coating weight depends upon the surface of the substrate, the presence or absence of a presize, and the size of the abrasive particles. Coating weights are generally within the range 1 to 250g/m², the lower end of the range being applicable to smooth substrates e.g. paper and fine grade abrasive particles.

Hot melt presize coatings may be applied in a similar manner to the make coating.

The abrasive particles are generally applied to the coated substrate immediately after application of the HMPU e.g. by passing the substrate through a curtain of abrasive particles or by electrostatic coating. Preferably the abrasive particles are heated prior to application e.g. from 30 to 150°C usually about 50°C.

A size may be applied directly after application of the abrasive particles. The size is preferably water-based and may readily be applied by spray-coating, roller-coating etc. The weight ratio of adhesive:water is generally within the range 10:1 to 1:2, preferably from 1:1 to 2:1. The coating weight is generally in the range 1 to 250g/m² solids and is normally dependent on the grade of abrasive particles.

In absence of a water-based size the material is preferably sprayed with water or placed in a moist

environment to cure the HMPU.

After application of size or water the material is dried e.g. by force drying in a tunnel oven with infrared heaters. Suitable drying temperatures are about 60°C and drying times of about 90 seconds are usually sufficient.

Following drying the abrasive element is preferably allowed to stand for a period of at least 24 hours to allow through curing of the HMPU.

A particularly preferred product in accordance with the invention is an abrasive sponge e.g. a foam strip of thickness in the range 2 to 15mm having abrasive coated on one major surface. The invention allows such a substrate coated with abrasive to be in sheet form or as a web from a roll. The sponge may be formed in situ in the apparatus upstream of the coating station. Foam blocks e.g. of thickness about 25mm may also be abrasive coated in accordance with the invention. The invention is not limited to coating a single surface and articles having double sized abrasive coatings optionally of different abrasive grade may readily be prepared. Abrasive Coating on some or all sides of a block is also possible.

The invention may employ abrasive particles of all types and grades. When using fine particles on a rough or porous substrate it may be desirable to employ a presize in the form of a transferable film to seal the surface thereby preventing the abrasive particles from entering the pores or cells and ensuring they remain at the surface.

The invention will now be illustrated by the following Examples.

Example 1

A series of abrasive elements were made by coating sheets of an open cell polyester foam having a density of 50 to 100 kg/m³ and a thickness of 5mm.

A presize coating of Evode Thermaflow 6876 (EVA)

was applied through an extrusion die at a temperature of 210°C.

5 Purmelt QR 3310-21 or Tivomelt 9617/11 was then applied over the hot presize from an extrusion die at a temperature of 120°C.

The coated sheet was immediately passed through a curtain of abrasive particles heated to 50°C. Excess particles were shaken from the coated sheet.

10 Water-based size was spray-coated over the sheet. The sizes used were Evode DP-90-4104 an acrylic adhesive and Witcobond 769 and Witcobond 788 a polyurethane adhesive at adhesive:water weight ratio of 2:1 for each size.

15 The resulting sheet was force dried in a tunnel oven at about 60°C for 90 seconds. Thereafter the sheets were stored on racks at ambient temperature for 24 hours. The sheets were tested for abrasive properties after 7 days.

The following samples were prepared:-

20 Sample 1

make : Purmelt QR3310-21 coating weight 60g/m²
size : Witcobond 769; coating weight 20-50g/m²
abrasive : P120 white Alox (aluminium oxide); coating weight 120g/m²

25 Sample 2

make : Purmelt QR3310-21; (200g/m²)
size : Witcobond 769 (20-50g/m²)
abrasive : P120 white Alox (120g/m²)

Sample 3

30 make : Tivomelt 9617/11
size : Witcobond 769 (20-50g/m²)
abrasive : P120 white Alox (120g/m²)

Sample 4

35 make : Purmelt QR3310-21 coating weight 80g/m²
size : Evode DP-90-4104
abrasive : P60 BFRPL (aluminium oxide)

Sample 5

make : Purmelt QR3310-21 coating weight 140g/m²
 size : Evode DP-90-4104
 abrasive : P60 BFRPL

Sample 6

5 make : Purmelt QR3310-21 coating weight 80g/m²
 size : Witcobond 788
 abrasive : P60 BFRPL

Sample 7

10 make : Purmelt QR3310-21 coating weight 140g/m²
 size : Witcobond 788
 abrasive : P60 BFRPL

The samples were tested by rubbing painted steel automobile panels both wet and dry. Coating loss was tested by folding material in half abrasive-to-abrasive and rubbing the two halves against each other. Samples 1 to 3 were experimental, and the respective coating weights given are only estimates. Sample 3 is based on a foam strip pre-coated with the polyurethane, of which the coating weight is unknown. In each of Samples 4 to 7, the size layer was applied with a dry coating weight of 20 to 40 g/m², and the abrasive with a coating weight of 450 to 500g/m². All samples gave acceptable performance in each test.

25 Example 2

Another experimental Sample 8 was made similar to Sample 1 except that a solvent-base polyurethane was employed as a size. The abrasive product had acceptable performance but not as good as samples using water-based size.

Example 3

A paper substrate was coated in a similar manner to Example 1 with the presize; a make consisting of Purmelt QR3310-21 (60 g/m²); a conventional urea formaldehyde size (20-50g/m²) and an abrasive coating of P120 white Alox (120g/m²). Sample 9 performed acceptably and was considerably more aggressive than the sponge

products.

Example 4

Samples were prepared in a similar manner to those in Example 1 utilizing an anti-loading composition as a size and supersize.

The anti-loading composition (ALC) comprised:
 210 parts by weight filled calcium stearate (Henkel Nopco EC 769)
 40 parts by weight water based acrylic binder (Vinacryl 71322)
 2 parts by weight fluorochemical ester/acrylate (3M FC396)

The mixture was diluted to 40% solids in water.

Sample 10

make : Purmelt QR3310-21 (75g/m²)
 size : Witcobond 769 (approx. 60g/m² dry)
 abrasive : P60 BFRPL (approx. 460g/m²)

Sample 11

make : Purmelt QR3310-21 coating weight 75g/m²
 size : ALC (approx. 90g/m² dry)
 abrasive : P60 BFRPL (approx. 460g/m²)

Sample 12

make : Purmelt QR3310-21 coating weight 75g/m²
 size : Witcobond 769 (approx. 60 g/m² dry)
 supersize : ALC (approx. 90g/m²)
 abrasive : P60 BFRPL (approx. 460g/m²)

All Samples gave satisfactory performance. Samples 11 and 12 gave improved cutting performance, both wet and dry, compared to Sample 10.

CLAIMS

1. An abrasive element comprising a substrate bearing layer of a moisture-cured hot melt polyurethane adhesive having abrasive particles embedded therein.
2. An abrasive element as claimed in Claim 1 in which said layer is overcoated with a size layer.
3. An abrasive element as claimed in Claim 2 in which the size layer is a water-based coating.
4. An abrasive element as claimed in Claim 2 or Claim 3 in which the size layer comprises acrylic, polyurethane, phenol, melamine or urea formaldehyde adhesive, a water based epoxy adhesive, or combinations thereof.
5. An abrasive element as claimed in Claim 2 in which the size layer comprises an acrylic binder and calcium stearate.
6. An abrasive element as claimed in any one of claims 2 to 5 in which the coating weight of the size is in the range 1 to 250g/m² solids.
7. An abrasive element as claimed in any preceding Claim which additionally comprises a supersize.
8. An abrasive element as claimed in Claim 7 in which the supersize comprises a binder and calcium stearate.
9. An abrasive element as claimed in any preceding Claim which comprises a presize layer between the substrate and the hot melt polyurethane adhesive.
10. An abrasive element as claimed in Claim 8 in which the presize layer comprises a hot melt adhesive.
11. An abrasive element as claimed in Claim 9 in which the presize layer comprises ethylene vinyl acetate, polyethylene or polyamide.
12. An abrasive element as claimed in any preceding Claim in which the coating weight of the hot melt polyurethane is in the range 1 to 250 g/m².
13. An abrasive element as claimed in any preceding Claim in which the substrate is selected from paper,

plastics fibres, fibrous bases, woven and non-woven fabrics, foams, and laminates thereof.

14. An abrasive element as claimed in Claim 13 in which the substrate is sponge sheet having a thickness in the range 2 to 15mm.

15. An abrasive element as claimed in Claim 1 substantially as herein described with reference to any one of the Examples.

16. A method of preparing an abrasive element which comprises applying a layer of a moisture-curable hot melt polyurethane adhesive to the surface of a substrate, depositing abrasive particles on said layer whilst the polyurethane adhesive is in a molten state and curing the polyurethane adhesive.

17. A method as claimed in Claim 16 in which the polyurethane adhesive is heated to a temperature of from 50 to 250°C prior to application.

18. A method as claimed in Claim 17 in which the polyurethane adhesive is heated to a temperature of about 120°C prior to application.

19. A method as claimed in any one of Claims 16 to 18 in which the coating weight of polyurethane adhesive is in the range 1 to 250g/m².

20. A method as claimed in any one of Claims 16 to 19 comprising the additional step of applying a size after application of the abrasive particles.

21. A method as claimed in Claim 20 in which the size is water-based.

22. A method as claimed in Claims 20 or 21 in which the size comprises acrylic, polyurethane, phenol, melamine or urea formaldehyde adhesive, a water based epoxy adhesive, or combinations thereof.

23. A method as claimed in any one of claims 20 to 22 in which the coating weight of the size is in the range 1 to 250g/m² solids.

24. A method as claimed in any one of Claims 16 to 23 comprising the additional step of applying a presize

layer on the substrate prior to application of the hot melt polyurethane adhesive.

25. A method as claimed in Claim 24 in which the presize is a hot melt adhesive and is applied in a molten state.

26. A method as claimed in Claim 24 or Claim 25 in which the presize comprises ethylene vinyl acetate, polyethylene or polyamide.

27. A method as claimed in any one of claims 16 to 26 in which the substrate is selected from paper, plastics fibres, fibrous bases, woven and non-woven fabrics, foams, and laminates thereof.

28. A method as claimed in Claim 27 in which the substrate is foam sheet having a thickness of about 5mm.

29. A method as claimed in any one of Claims 16 to 28 in which the abrasive particles are heated to a temperature of from 35 to 250°C prior to deposition.

30. A method as claimed in Claim 29 in which the abrasive particles are heated to a temperature of about 50°C.

31. A method as claimed in Claim 16 substantially as herein described with reference to any one of the Examples.

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Relevant Technical Fields

- (i) UK Cl (Ed.L) C4V (V1); C3V (VDB)
 (ii) Int Cl (Ed.5) B24D 3/00; 3/02; 3/20; 3/28; 3/30; 3/32

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 2 DECEMBER 1993

Databases (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-
 1-31

(ii) ONLINE DATABASE: WPI

Categories of documents

- X: Document indicating lack of novelty or of inventive step. P: Document published on or after the declared priority date but before the filing date of the present application.
 Y: Document indicating lack of inventive step if combined with one or more other documents of the same category. E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.
 A: Document indicating technological background and/or state of the art. &: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 0851844 I (RAYBESTOS-MANHATTAN) see Example III	1
A	US 4336293 A (EIDEN) see column 2, lines 49-52	1

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).